Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

1.9411
L70p2

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS

Operations Guidance Report on

WATER FACILITIES FOR
BEAR BUTTE CREEK WATERSHED
ELK CREEK WATERSHED
BOXELDER CREEK WATERSHED

SOUTH DAKOTA

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

June 1940

LIBRARY
RECEIVED
OCT 8 - 1953
U. S. DEPT. OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS
WASHINGTON, D. C.

July 26, 1940.

GRP.

MEMORANDUM FOR MR. GEORGE R. PHILLIPS,
CHAIRMAN, WATER FACILITIES BOARD.

Dear Mr. Phillips:

Attached is a copy of "Operations Guidance Report on Water Facilities for Bear Butte Creek Watershed, Elk Creek Watershed, Boxelder Creek Watershed, South Dakota."

This report was released by Mr. E. C. Gwillim, District Water Utilization Supervisor, to field representatives of S.C.S. and F.S.A. The dates of the releases and the names of the individuals of S.C.S. and F.S.A. who have received copies are given below:

Copies Released to	Date of Release
Cal A. Ward, F.S.A. Lincoln, Nebraska (4 copies)	July 13, 1940
A. E. McClymonds, S.C.S. Lincoln, Nebraska (3 copies)	July 13, 1940

A copy of this memorandum is being sent to Mr. Bear and Mr. Hauter.

Very truly yours,

M. M. Kelso

M. M. Kelso,
B.A.E. Member,
Water Facilities Board.

Attachment

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS

Operations Guidance Report on

WATER FACILITIES FOR BEAR BUTTE CREEK WATERSHED ELK CREEK WATERSHED BOXELDER CREEK WATERSHED

SOUTH DAKOTA

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

Under the Provisions of the Water
Facilities Act
(Public Law No. 399, 75th Congress)

June 1940

BUREAU OF AGRICULTURAL ECONOMICS
Washington, D. C.

MEMORANDUM

To: Mr. M. M. Kelso, Head,
Division of Land Economics.

Dear Mr. Kelso:

The following Operations Guidance Report on Water Facilities for Bear Butte Creek Watershed, Elk Creek Watershed and Boxelder Creek Watershed, South Dakota, was prepared under the general supervision of Edward C. Gwillim, District Water Utilization Supervisor.

Wendell C. Munson, Assistant Hydraulic Engineer, was assigned direct responsibility for the field work and the preparation of the report. He was assisted directly by Kirk M. Sandals, Assistant Hydraulic Engineer. George P. Lachar, Assistant Economist, analyzed the economic data and assisted Mr. Munson in the preparation of the report.

Very truly yours,

Homer M Wells

Homer M. Wells, Acting in Charge,
Water Utilization Section,
Division of Land Economics.

ACKNOWLEDGMENTS

The data and material for this report were obtained from reconnaissance field surveys and previous reports. Acknowledgment is made of the information, materials, and assistance rendered by the following organizations and individuals: Soil Conservation Service, Farm Security Administration, United States Geological Survey, United States Weather Bureau, United States Army Engineers, County Agricultural Agents of Meade and Pennington counties, State Engineer of South Dakota, South Dakota State School of Mines, and various members of the County Land Use Planning Committees of Meade and Pennington counties. The Rapid City Chamber of Commerce also offered material aid in locating certain engineering reports which were made available to the Bureau.

AUTHORIZATION

This report on the development of small water facilities for Bear Butte Creek, Elk Creek, and Boxelder Creek watersheds has been prepared under the authority and provisions of the Water Facilities Act (Public No. 399 - 75th Congress) approved August 29, 1937, and the Secretary of Agriculture's memorandum of July 1, 1938, on administration of the Water Facilities Program.

Bear Butte, Elk, and Boxelder Creek watersheds were authorized for area planning May 1, 1939, as indicated in South Dakota State Memorandum No. 4. Operations were authorized by the Water Facilities Board on November 1, 1939, to proceed concurrently with area planning as soon as the Bureau of Agricultural Economics can supply an "Operations Guidance Report." Formal notification of the Board's action is contained in South Dakota State Memorandum No. 7, dated November 6, 1939.

LIST OF TABLES

Table 1. Variations in Precipitation for the Months of April to July Inclusive, During the Period 1888 to 1939, at Rapid City, South Dakota. 9

Table 2. Water Rights and Dry Draw Filings on Bear Butte, Elk, and Boxelder Creek Watersheds, South Dakota, January 5, 1940 15

Table 3. Farm Security Administration Grants and Loans in the Bear Butte and Elk Creek Districts of Meade County, South Dakota, During the Period May 1939 to January 1, 1940. 21

Table 4. Per Acre Yields of Wheat in Meade County and Pennington County, South Dakota, on a Seeded Acreage Basis, 1923 to 1939 23

Table 5. Percentage Distribution of Operating Units by Type of Farming and Average Size of Farm in Lawrence, Meade, and Pennington Counties, South Dakota, 1930. 26

Table 6. Size of Farms in Lawrence, Meade, and Pennington Counties, South Dakota, 1935. 27

TABLE OF CONTENTS

Page

AUTHORIZATION . . . .
ACKNOWLEDGMENTS . . . .
SUMMARY 1
RECOMMENDATIONS 3
PURPOSE AND SCOPE 5
I DESCRIPTION OF THE AREA 6
Location and Size 6
Topography. 7
Climatic Conditions 7
Geology and Ground Water. 10
Soils and Vegetative Cover. 11
Surface Water 12
Water Rights. 13
Existing Water Facilities 15
Past Irrigation Investigations. 17
II ECONOMIC CONDITIONS IN THE AREA 19
Population, Transportation, Markets, and Public Facilities 20
Farm Security Administration Loans and Grants 21
Land Ownership and Farm Tenure. 22
Present Land Use. 23
III RECOMMENDED LAND USE AND DEVELOPMENT OF WATER FACILITIES. 28
Recommended Land Use. 28
Recommended Water Facilities Development. 29
IV VALUE OF WATER FACILITIES 32
APPENDIX I - Charts and Maps. 33

SUMMARY

The Bear Butte, Elk, and Boxelder Creek watersheds are located in west central South Dakota and occupy portions of Lawrence, Meade, and Pennington counties.

The topography of the area is mountainous at the headwaters, and there is a sharp break from mountainous to plains characteristics about 15 miles below the headwaters.

The climate of the area is generally semiarid, with widely varying and extreme temperatures and highly variable and erratic precipitation. Precipitation is influenced by the Black Hills Mass, and, because of this influence, is frequently much higher than normal. Periods of drought alternate irregularly with periods of above normal rainfall.

In the Black Hills portion of the area, exposed geologic materials consist of limestone, sandstone, shale, granite, and schist. The rolling plains are composed primarily of shale and clay. Stream valleys and upland divides contain alluvial gravels, sand, and clay in thickness of from 1 to 30 feet. Ground water is generally available in the headwater areas at depths of from 10 to 1,200 feet. In the plains portion, ground waters are not economically available except along streams and locally on interstream areas.

The streams in the area generally have a moderate flow in their upper reaches, due primarily to discharge of springs. However, in all the streams the late summer flows are entirely dissipated as they

pass over the limestones and sandstones at the eastern edge of the Black Hills.

The waters of South Dakota belong to the public, and the non-navigable waters are subject to appropriation for beneficial use. The streams in the area are greatly overappropriated, and care must be exercised not to interfere with prior water rights in any water conservation development.

Existing water facilities consist of direct flow irrigation, stock water ponds, farmstead wells, and a few flood irrigation facilities.

There was considerable interest in irrigation about 1929, and some later investigations were made prior to the time that this reconnaissance survey was made. There has been no development of these proposed projects.

The area is used primarily for livestock production. Approximately 10 per cent of the land is under cultivation. Cash crop production has decreased materially during the drought. Wheat yields averaged about 9 bushels per acre during the period 1923 to 1939, and averaged about 6 bushels per acre during the last 10 years.

Although it is realized that the recommendations made in this report are of a very general nature and subject to variations in individual cases, water facilities should not be developed on units which do not meet at least the minimum requirements as set forth herein, without careful consideration and justification.

RECOMMENDATIONS

1. New direct flow irrigation development should not be contemplated. Until such time as there is a definite break in the period of low rainfall, development of flood irrigation should be limited to locations which have sufficient drainage area to provide run-off during this dry period and which have sufficient potential irrigable acreage to utilize the increased run-off during periods of normal precipitation.
2. Stock water reservoirs should be constructed with sufficient depth to carry water over for one year.
3. Neither flowing nor pumped artesian wells are believed to be economical in the plains portion of the area unless other means of supplying farmstead and livestock water are not available, and in no case should artesian wells be drilled with the intent of supplementing stream flow for livestock use. Artesian wells should be drilled only after detailed investigations of an individual location have been made.
4. In the Black Hills and areas immediately adjacent thereto, pumped and flowing wells should provide ground water for range livestock and farmstead uses. Some flowing wells may provide for the irrigation of tracts larger than farmstead gardens.
5. Existing irrigation facilities should be reconditioned and due consideration given to the possibility of combining some of the present direct flow irrigation systems.

6. Mechanical plugging of sink holes is not recommended.
7. Major reliance for farm income should be placed upon livestock production.
8. The minimum unit recommended requires long-time control of at least five ~~six~~ sections of grazing land and sufficient crop land to provide winter feed and adequate feed reserves.
9. As much as possible of the food needed to meet family requirements should be produced on each of the operating units in the area. Wherever possible, advantage should be taken of available water facilities in providing family size irrigated gardens.

PURPOSE AND SCOPE

The purpose of this report is to furnish guidance to the operating agencies of the Water Facilities Program in the development of water facilities on Bear Butte, Elk, and Boxelder Creek watersheds, South Dakota.

The scope of this report is limited to indicating the physical limitations of the development of water facilities in accordance with the proper utilization of land and water resources of the areas. Because of their locations and other similar characteristics which tend to blend the problems of the different watersheds, these areas have been considered jointly in one report.

I

DESCRIPTION OF AREA

Location and Size

The Bear Butte, Elk, and Boxelder Creek watersheds are located in west central South Dakota and occupy portions of Lawrence, Meade, and Pennington counties.

Bear Butte Creek Watershed, the northernmost, is bounded on the north by the Whitewood Creek Drainage, and on the south by the Alkali Creek Drainage. It occupies an area of about 210 square miles and flows northeastward from the Black Hills for about 35 miles to the Belle Fourche River.

The headwaters of the Elk Creek Watershed lie south of the headwaters of Bear Butte Creek. Elk Creek flows eastward for about 75 miles to enter Cheyenne River and has a drainage area of about 550 square miles. The watershed is bounded on the north by the drainage of Alkali Creek and on the south by the drainage of Boxelder Creek.

Boxelder Creek Watershed, which lies south of the Elk Creek Drainage and north of the drainage of Rapid Creek, has a drainage area of about 400 square miles. Boxelder Creek rises in the Black Hills and flows generally eastward for about 60 miles to its confluence with the Cheyenne River.

Topography

All three streams rise in the Black Hills, and the upper portions of their basins may be classed as mountainous. The streams leave the Black Hills about 15 miles below their headwaters and break into an area of rolling plains, interrupted occasionally by undulating to heavily rolling areas. The principal topographic feature of the area is Bear Butte, a large rhyolite plug, which rises about 1,400 feet above the adjoining plains. Elevations vary from about 6,200 feet above sea level at the headwaters to about 2,400 feet at the eastern edge of the area.

Major stream valleys are narrow, V-shaped canyons in their upper portions, but become wide, flat-bottomed, and commonly U-shaped upon reaching the margin of the Black Hills. Existing channels meander within the confines of the valley proper.

Tributary valleys are rapidly falling drains which have well defined channels and which break sharply onto broad terraces and stream bottoms. Interstream areas are undulating to rolling.

The lower portions of Elk and Boxelder Creeks have established a heavily rolling to rough and broken topography.

Climatic Conditions

The climate of the area is generally semiarid, with widely varying and extreme temperatures and highly variable and erratic precipitation. The precipitation is influenced by the Black Hills Mass and is frequently much higher than normal. Periods of drought alternate irregularly with periods of above normal rainfall.

Records of the United States Weather Bureau Stations within the area, at Fort Meade, and adjacent to the area, at Rapid City, show the normal precipitation to be 20.29 and 17.45 inches respectively. The record at Fort Meade is for the 40-year period, 1879 to 1918, and that at Rapid City is for the 52-year period, 1888 to 1939. About 75 per cent of the annual precipitation occurs during the growing season, April to September, inclusive. Table 1 shows the variation in precipitation at the station at Rapid City, South Dakota, during the critical portion of the growing season.

Table 1.—Variations in Precipitation for the Months of April to July inclusive, During the Period 1888 to 1939, at Rapid City, South Dakota

	Years of Record		Years Below Normal				Range	
Month	Number	Normal Precip-itation (inches)	Number	Average Precip-itation (inches)	Per Cent of Total Years	Per Cent of Normal	Max	Min. (inches)
April	52	1.89	31	0.94	59.6	49.7	4.49	0.32
May	52	3.39	28	2.13	53.8	62.8	8.15	0.09
June	52	3.20	26	2.00	50.0	62.5	7.54	0.50
July	52	2.33	32	1.28	61.5	54.9	9.66	0.13

Source:- U. S. Department of Agriculture Weather Bureau Records.

As shown in Table 1, from 50.0 to 61.5 per cent of the years of record have had below normal rainfall during the early part of the growing season. During these months of below normal precipitation, the rainfall varied from 49.7 to 62.8 per cent of the normal. These records illustrate the futility of normal rainfall expectancy. Precipitation has been below normal every year since 1933, and the annual precipitation during this 6-year period has been only 70 per cent of the normal. This indicates the need for the conservation and wise utilization of available water resources to assure crop production in this area.

Summer rains are usually local and are occasionally of cloudburst intensity. The greatest precipitation recorded in a 24-hour period at Rapid City was 5.57 inches, in May 1920. Summer storms are frequently accompanied by high winds, and severe hail storms are not uncommon. Snowfall in the area averages about 34 inches and drifts considerably.

Temperatures vary from 106° above to 34 below zero. The mean annual temperature is 47°. The average maximum temperature is about 58°, and the average minimum temperature is about 35°. The frost-free period is about 154 days.

The prevailing wind in the area is from the west in the fall and from the north the remainder of the year with the exception of June, when it is from the south. Average wind velocity is about 8 miles an hour. Chinock winds occur occasionally during the later winter months and cause sudden and sharp rises in temperature. June and July winds are often hot, dry, and of high velocity, and are often destructive to growing crops.

Geology and Ground Water

In the Black Hills portion of the area, exposed geologic materials consist of limestone, sandstone, shale, granite, and schist. The rolling plains are composed primarily of shale and clay. Stream valleys and upland divides contain alluvial gravels, sands and clay in thicknesses of from 1 to 30 feet.

The formations in this area dip to the east. Formations in the Black Hills dip more steeply than those in the plains and are carried to considerable depths underground within a few miles eastward from the margin of the Hills.

~~[illegible]~~

~~[illegible]~~

Ground waters, which in most cases are of satisfactory quantity and quality for livestock and farmstead uses, occur in the sandstones and alluvial materials of the Black Hills and in the alluvial materials of the plains. In certain localities these waters are available to pumped wells from depths of 10 to 300 feet, and to artesian wells, which may be either flowing or non-flowing, from depths of 200 to 1,200 feet. A description of geology and the availability and character of ground water, by ground-water areas, is given on Map 2.

With special reference to artesian areas, it is suggested that drilling be initiated only after detailed investigations of an individual location have been carried out. Further, wells which derive their supply from the same water-bearing formation should not be located in such proximity that they will interfere with the yield of each other.

Soils and Vegetative Cover

The soils of the area are primarily residual and are derived largely from the Pierre shales. The predominating soils are clays and clay loams, and they are used primarily for grazing purposes. The portion of the area most extensively cultivated is located immediately east of the Black Hills, where the soils are derived from

the Spearfish sandy shales and sandstones. The terraces and alluvial bottomlands throughout the area are likewise utilized for crop production. Moderate wind and sheet erosion are in evidence in the lower portions of all three drainages of the area.

The dominant type of vegetation in the area is the short grasses. On the interstream areas and rolling uplands the vegetative cover consists primarily of blue grama and nigger wool. On the terraces, sandgrass and needlegrass predominate, whereas on the creek bottoms the cover consists of a mixture of grasses, principally western wheatgrass. The Black Hills area of the upper stream basins also supports considerable timber growth, mostly pine and spruce. The carrying capacity of the grassland in the area is estimated at about 30 surface acres per animal unit for a 12-month grazing period. The grazing period varies from 8 to 10 months per year.

Surface Water

There are no gaging stations maintained in the area. There was a station on Boxelder Creek at Blackhawk, South Dakota, during portions of 1903, 1904, 1905, and 1906. The maximum, minimum, and mean annual discharges in acre-feet were 35,500, 16,400, and 26,000, respectively, during this period of record.[1] The streams in this

---

[1] House Document No. 190, 72nd Congress, 1st Session, Army Engineers Report Cheyenne River, South Dakota and Wyoming.

area generally have a moderate flow in their upper reaches, due primarily to discharge from springs. However, in all three streams the late summer flows are entirely dissipated as they pass over the Pahasapa, Englewood, and Whitewood limestones and Minnelusa, Lakota, and Dakota sandstones.[1] Because of these geologic conditions it is believed that any estimates of run-off for the entire basin of any one of these streams would be misleading. It appears that there is no assured water supply available for irrigation or storage. Estimates of run-off should be made for each facility before construction is contemplated.

To assist in determining available stream flow, gaging stations should be established at strategic points in the area and should operate concurrently. The following locations are suggested for gaging stations: Immediately above the first sink holes, immediately below the last sink holes, and at the mouths of each stream.

Water Rights

The waters of South Dakota belong to the public, and the non-navigable waters are subject to appropriation for beneficial use. Prior use establishes prior right and water for irrigation purposes is appurtenant to the land. There are two main distinctions in the classes of water rights, water rights on non-navigable

---

[1] Shown on Map 2.

streams and water rights on dry draws. The distinction is defined thusly: "The words 'dry draw' and 'water course', as used in this section, shall be construed to mean any ravine or watercourse not having a flow of at least twenty miner's inches of water during the greater part of the year .... One cubic foot of water per second is equivalent to fifty miner's inches."[1] Bear Butte, Elk, and Boxelder creeks are classified as non-navigable streams in the State Engineer's office.

The dry draw appropriation was intended to allow settlers and landowners to construct reservoirs for impounding storm waters without having to incur the expense of making surveys and submitting applications in regular form to the State Engineer. The law merely requires a location certificate to be filed with the Register of Deeds in the county in which the appropriation is made, a copy posted at the point of diversion, and another copy filed with the State Engineer. If these requirements are fulfilled within 60 days after posting the certificate and the water is put to beneficial use, the appropriator then has the right of such water in accordance with his location certificate. Then if the appropriator desires a certificate from the State Engineer to the effect that he has a water right under the laws of the State (state water right), he is required to petition the State Engineer for it.

There are many water rights on the streams in this area. Table 2 shows the total filings for each drainage.

---

[1] State of South Dakota - Regular Legislative Session of 1939 - Code Revision Report, Volume VIII.

Table 2.--Water Rights and Dry Draw Filings on Bear Butte,
Elk, and Boxelder Creek Watersheds, South Dakota,
January 5, 1940

Watershed	Water Rights Cubic Feet per Second	Dry Draw Filings Number
Bear Butte	115.25	4
Elk Creek	396.10	12
Boxelder Creek	1,385.10	24

Source: Records from the State Engineer's office, Pierre, South Dakota.

The locations of the water rights making up the totals shown in Table 2, are shown on Map 1. The waters of these streams are greatly overappropriated and care must be exercised in any water conservation development not to interfere with prior water rights.

Existing Water Facilities

Existing water facilities within the drainages of Bear Butte, Elk, and Boxelder creeks consist of direct flow irrigation, stock water ponds, farmstead wells, and a few flood irrigation facilities. There are several artesian wells in the vicinity of Sturgis and Rapid City.

Irrigation has been practiced by several operators in the area for many years, as is evidenced by the number of old water rights. Most of these irrigated acreages, however, were dependent upon flood flows and often did not have sufficient water during the late summer months.[1] There have been several water spreading

---

[1] Statement of operators residing in the area.

and flood irrigation units installed within the past year by the Fort Meade Civilian Conservation Corps Camp under the supervision of the Soil Conservation Service. These units did not operate successfully during the 1939 season. Precipitation during the 1939 growing season, especially after the 6-year period of low precipitation, was insufficient to cause run-off. Moreover, the 1939 season was the warmest in the history of the Weather Bureau station at Rapid City.[1]

There are two irrigation projects in the area, which serve about 750 acres. One is located on Elk Creek and the other on Boxelder Creek, as shown on Map 1. They both divert water directly from the stream channel by means of a concrete overflow dam. Water is distributed by means of gravity ditches. For several years there has been insufficient stream flow to operate either system.[2]

Annual water requirements as estimated for the proposed Rapid Creek Project are 3.80 acre-feet per acre.[3] It is believed that the figure would be applicable to lands within any of the three drainages considered in this report.

---

[1] U. S. Department of Agriculture Weather Bureau Station.

[2] Statement of operators.

[3] Report on Rapid Valley Irrigation Project, South Dakota, U. S. Department of the Interior, Bureau of Reclamation.

Past Irrigation Investigations[1]

Considerable interest in irrigation was manifest in the area in 1920, and the Rapid City Chamber of Commerce hired M. H. Chapman, a consulting engineer, to make a report on irrigation possibilities of the streams flowing eastward from the Black Hills, from Elk Creek on the north to Beaver Creek on the south. Several dam and reservoir sites were investigated, two of which were on Elk Creek and two on Boxelder Creek.

The sites investigated on Elk Creek contemplated offstream storage of flood flows in reservoirs designated as Elk No. 1 and Elk No. 2, which are shown on Map 1. These two sites were examined in detail, surveys made, and maps and cost estimates prepared. Several plans of development were considered with estimated construction costs varying from $60,016.60 to $107,038.40.

The sites investigated on Boxelder Creek contemplated storage in the stream channel and are designated as Site No. 8 and Boxelder Reservoir on Map 1. The Forest Service dug several test pits in the vicinity of Site No. 8 and discovered unsatisfactory foundation conditions.[2] The Boxelder Reservoir site was surveyed, and a proposed irrigation district was mapped in 1930 by E. C. Lewis, an engineer. No cost estimates were available for any of the proposed storage reservoirs on Boxelder Creek.

In regard to storage of water upon these streams, Mr. Chapman

---

[1] Information, Reports, and maps furnished by the Rapid City Chamber of Commerce.

[2] Statement of a member of the Pennington County Land Use Planning Committee.

makes this statement: "In view of failures of storage reservoirs in various sections of this country, to hold water economically and successfully (not on account of poor construction, but on account of nature of the reservoir bed itself, porous conditions, and inability of the builders to successfully puddle and make nearly water tight the floors or beds of the available storage areas), I recommend that no large dams, nor large areas of storage be attempted until at least one small dam and reservoir has been completed and tested."

At the time the field investigations were carried on by the Bureau of Agricultural Economics, major interest was centered on stock water, water spreading, and flood irrigation development.

II

ECONOMIC CONDITIONS IN THE AREA

The area is primarily an agricultural area with little industrial development. There is a small bentonite plant at Sturgis, a plaster plant at Piedmont, and numerous small sawmills and gold mines in the Black Hills portion of the area.

The first settlers, who were hunters and trappers, came to the area about 1873. An army post near the present site of Fort Meade was later established, and, as the Indians were driven further west, cattlemen settled in the area. However, no large influx of settlers occurred until the area was opened for homesteading about 1900. The early cattlemen operated large units and utilized the free range. They produced only crops sufficient for their immediate needs. With the large influx of settlers, the smaller ranch units were displaced. The larger cattle operators remained in the area but were forced to raise more feed because of the restricted range. The drought period about 1911 forced many of the homesteaders to leave, but the war boom of 1914 to 1918 brought many of them back, and much of the area was devoted to the production of wheat. Recent years of drought and decreased farm income, due to low prices, have caused the abandonment of many of the dry land farming units and a decrease in the number of cattle.

Population, Transportation, Markets, and Public Facilities

The total population of the area is estimated at 5,000, about one-half of which is rural. The principal town, Sturgis, which has a population of about 2,000, is the county seat of Meade County.

The Chicago and Northwestern Railroad traverses the Boxelder Creek Watershed from east to west and extends north from Rapid City through Sturgis. Numerous Federal, State, and county roads provide adequate highway facilities.

Sturgis and Rapid City are the principal shipping points for cattle produced in the area. There is sufficient local demand for hay, forage, and garden truck produced in the area, but during the drought periods there has been a serious shortage of these items.

A power line parallels the railroad and serves the larger towns in the area. The Rural Electrification Administration has a project in the area. There is a natural gas line of the Montana-Dakota Utilities Company, which serves Rapid City, Sturgis, and other towns. The towns are served by telephone and telegraph, and several farm telephone lines serve the rural areas.

Rural schools are located throughout the area. High Schools are located at Sturgis, Piedmont, and Rapid City. There are churches in the towns, and there are a number in the rural areas. The South Dakota State School of Mines is located at Rapid City.

Farm Security Administration Loans and Grants

Available information on assistance given by the Farm Security Administration to operators was obtained for watersheds of Bear Butte and Elk Creeks. However, it is believed that these figures are also representative of Boxelder Watershed. Table 3 shows the number of operators receiving loans or grants and approximate amounts expended for grants, emergency loans, and standard loans.

Table 3.—Farm Security Administration Grants and Loans in the Bear Butte and Elk Creek Districts of Meade County, South Dakota, During the Period May 1935 to January 1, 1940

District	Grants		Loans				
	Number of Clients	Amount	Number of Clients	Amounts		Repayments	
				Emergency	Standard	Emergency	Standard
Bear Butte Creek	190	$55,120	119	$4,847	$44,066	$639.26	$6,929.17
Elk Creek	145	43,121	56	2,323	22,058	437.36	2,417.25

Source: Farm Security Administration, Sturgis, South Dakota.

During the period May 1935 to January 1, 1940, the Farm Security Administration had 335 grant clients who had received $98,241, and 175 loan clients who had received $7,170 in emergency loans and $66,124 in standard loans.

Land Ownership and Farm Tenure

Available information on land ownership was obtained for Meade County, and it is believed to be indicative of the remainder of the area. As of January 1, 1938, about 55 per cent of the land in the county was owned by private individuals, 4 per cent by corporations, 30 per cent by the County, 10 per cent by the State, and 1 per cent by the Federal Government.[1]

According to the 1935 U. S. Census, there were 490 farms in Lawrence County, 1,756 in Meade County, and 1,311 in Pennington County. About 50 per cent of the farms in Lawrence County were operated by owners, 32 per cent by tenants, and the remainder by part owners. In Meade County, only about 36 per cent of the farms were operated by owners, 29 per cent by tenants, and 35 per cent by part owners. Similarly, about 35 per cent of the farms in Pennington County were operated by owners, 39 per cent by tenants, and the remainder by part owners. It is believed that the present number of farm operators in those counties is somewhat less than that indicated by the Census, as some dry land farming units have been abandoned because of the drought. It appears that the average operator in the area owns about 25 per cent of the land in his unit and rents the remainder.

---

[1] Data furnished by Agricultural Agent, Meade County.

Present Land Use

The area is primarily a livestock area, although there is some production of cash grain. Information obtained for Meade County shows that about 10 per cent of the land is under cultivation, 40 per cent is in the restoration program of the Agricultural Adjustment Administration, and about 50 per cent is in range. The cultivated land is used for the production of wheat and forage crops.[1]

Available data on wheat yields for Meade and Pennington counties are shown in Table 4.

Table 4.--Per Acre Yields of Wheat in Meade County and Pennington County, South Dakota, on a Seeded Acreage Basis, 1923 to 1939

Year	Bushels per Acre	
	Meade County	Pennington County
1923	9.9	12.2
1924	12.0	10.1
1925	16.3	18.4
1926	14.6	14.9
1927	15.9	18.7
1928	14.6	13.1
1929	11.7	14.0
1930	10.4	10.0
1931	1.9	1.8
1932	18.9	21.6
1933	8.0	3.3
1934	2.1	1.2
1935	9.5	9.4
1936	1.8	1.2
1937	7.6	6.4
1938	3.0	3.1
2/ 1939	1.5	1.5
1923-39 average	9.4	9.5
1923-29 average	13.6	14.5
1930-39 average	6.5	6.0

Source: U. S. Department of Agriculture, Agricultural Marketing Service.

---

1 Data furnished by Agricultural Agent, Meade County.

2 Preliminary.

On a seeded acreage basis, the average annual per acre yield of wheat for the period 1923 to 1939 inclusive, is 9.4 bushels for Meade County and 9.5 bushels for Pennington County. During the last 10 years, yields have averaged 6.5 and 6.0 bushels for Meade and Pennington counties, respectively. In the first 7 years of the period 1923 to 1939, yields averaged 13.6 bushels for Meade County and 14.5 bushels for Pennington County. Chart 1 indicates that precipitation was below normal during 8 of the last 10 years, whereas during the first 7 years of the period below normal precipitation occurred only in 2 years, 1924 and 1928. As a yield from 6 to 7 bushels per acre is considered locally as being necessary to repay production costs, it may be readily seen that there is little profit in wheat production in this area during years of below normal precipitation.

During a few years in the early thirties, when wheat yields in the area were better than average, prices were relatively low. Over a period of years, therefore, the combined effect of low yields and relatively low prices makes it impossible, in most instances, for a farm family to obtain an income adequate for family living without financial aid from sources other than the farm unit when major reliance for farm income is placed on wheat production.

According to the 1930 U. S. Census, only about 23 to 33 per cent of the operating units in the three counties was classified as stock ranches. From 8 to 28 per cent of the units was classified as cash grain farms, and from 16 to 19 per cent as general farms. However, about 55 per cent of the land in farms in Lawrence County, 60 per cent in Meade County, and about 45 per cent in Pennington County were in livestock units. Table 5 shows the percentage distribution of operating units and average size of farms by type of farming for each of the three counties. As previously indicated, some changes have since occurred because of the drought. The types of operating units considered to be prevalent in the area are livestock units and combination cash grain and livestock units.

Table 5 also indicates the variations in the average size of operating units by types of farms. Stock ranches predominate in these counties and average in size from 726 to 1,286 acres. Cash grain farms are of variable importance in the three counties and vary from 491 to 662 acres in size.

Table 5.--Percentage Distribution of Operating Units by Type of Farming and Average Size of Farm in Lawrence, Meade, and Pennington Counties, South Dakota, 1930

Type of Farming	Lawrence County		Meade County		Pennington County	
	Per cent	Average Size in Acres	Per cent	Average Size in Acres	Per cent	Average Size in Acres
Stock Ranch	24	726	33	1,186	23	1,286
Cash Grain	8	491	22	617	28	662
General	16	115	19	435	16	469
Animal Specialty	5	131	6	306	4	175
Crop Specialty	7	440	4	537	6	415
Self-sufficing	7	107	1	229	2	190
Dairy	15	296	4	456	5	399
All other	18	---	11	---	16	---
Total	100	361	100	710	100	681

Source: U. S. Census, 1930.

More recent Census data on the variation in size of operating units in these counties is shown in Table 6. It is estimated therefrom that only about 15 per cent of the farms in Lawrence County, 40 per cent in Meade County, and about 25 per cent in Pennington County, were larger than 640 acres in size. These farms occupied, however, 55 per cent of the acreage in farms in Lawrence County, 75 per cent in Meade County, and about 70 per cent in Pennington County.

Table 6.---Size of Farms in Lawrence, Meade, and Pennington Counties, South Dakota, 1935

Size Group (Acres)	Number of Farms		
	Lawrence County	Meade County	Pennington County
Under 99	153	88	157
100 - 174	98	194	228
175 - 259	33	90	86
260 - 379	50	271	191
380 - 699	88	449	294
700 - 999	26	211	128
1,000 and over	42	453	227
Total	490	1,756	1,311

Source: U. S. Census, 1935.

III

RECOMMENDED LAND USE AND DEVELOPMENT OF WATER FACILITIES

Recommended Land Use

It is believed that the area is best suited to the production of livestock because of the highly variable and erratic occurrence of precipitation. As a result of the recent drought, the proportion of the area used for crop production has been gradually reduced. Major reliance for farm income, therefore, in all instances should be placed upon livestock production. Under favorable moisture conditions, however, some acreage will probably be used for the production of cash grain.

On the basis of a previous report covering a portion of Meade County, it is believed that a total of 150 animal units[1] is necessary in this area to pay average farm overhead and operating expenses and to provide the average farm family with a minimum income adequate for family living.[2] On the basis of the estimated carrying capacity of range land in this area, 20 surface acres per animal unit are required for an 8-month period. It is necessary, therefore, that operators in this area with minimum cattle units have long-time control of at least 5 sections of grazing land. In addition, operators should control enough crop land to provide winter feed and adequate feed reserves. It is recommended that any contemplated wheat production during periods of favorable moisture be limited to a part of that portion of a unit devoted to the production of feed crops.

---

[1] An animal unit is a range cow weighing 1,000 pounds or its equivalent.

[2] U. S. Department of Agriculture, Bureau of Agricultural Economics, Water Facilities Area Plan for Subarea I (Northern Slope) Cherry-Sulphur Creek Watershed, South Dakota, February 1939.

As much of the family food requirements as practicable should be produced on each of the operating units in the area. Wherever possible, advantage should be taken of available water facilities in providing a family size irrigated garden.

These recommendations are of a very general nature and subject to variations in individual cases. However, water facilities should not be developed on units which do not at least meet these minimum requirements, without careful consideration and justification.

Recommended Water Facilities Development

There are several locations in the area where water can be stored. However, the estimated construction costs of reservoirs at these sites exceed the limitation of cost as set forth in the Water Facilities Act.

Flood irrigation presents the best opportunity for water utilization. There are many draws having sufficient drainage area and suitable topography to cause flash run-off following heavy rains. During the past few years, however, these rains have failed to materialize and as a result there has been limited run-off. It is recommended therefore, that until such time as there is a definite break in the period of low rainfall and an increasing amount is noticeable, development should be limited to locations which have sufficient drainage area to provide run-off during this dry period and which have sufficient potential irrigable acreage to utilize the increased run-off during periods of normal precipitation. Care must be exercised that no existing water rights are infringed upon.

Although there are many stock water reservoirs in this area, the principal problem is a shortage of livestock water. Few of the stock water reservoirs contained water at the time that the reconnaissance survey was made. Limited run-off, due to insufficient precipitation, and, to a limited extent, evaporation from reservoirs of insufficient depth, were responsible for this condition. It is recommended, therefore, that all stock water reservoirs be constructed with a minimum depth sufficient to carry water over for 1 year.

In the Black Hills and areas immediately adjacent thereto, ground waters for livestock and farmstead uses are almost everywhere available to pumped wells from depths of 10 to 1,200 feet and to flowing wells from depths of 200 to 1,200 feet. Most pumped wells need not exceed 500 feet. Some flowing wells should provide water for the irrigation of tracts larger than farmstead gardens. The construction of flowing wells to supplement streamflow for livestock uses is believed impracticable.

In most of the plains portion of the area, ground waters for livestock and farmstead uses are not economically available except to shallow wells, 10 to 50 feet, along streams, and locally on interstream areas. Deep wells, 1,000 to 3,000 feet, to obtain either flowing or pumped artesian wells are believed not to be economic unless other means of supplying livestock and farmstead water are not available.

As an alternative to the use of surface or ground water for garden irrigation and as a desirable water conservation practice, snow

traps should be utilized to catch drifting snow.

New direct flow irrigation development should not be undertaken, because of overappropriation of present stream flow. The possibility of combining some of the present direct flow irrigation systems to better utilize the existing water supply should receive careful consideration. Existing irrigation facilities should be reconditioned.

The installation of stream gauges at strategic points is recommended.

The sink holes on Spring Creek, just south of the area, have been plugged by mechanical means. Observation of the effectiveness of this work compared with the cost will give a basis for determining the feasibility of similar measures on the streams in this area. Such work is not recommended at this time.

IV

VALUE OF WATER FACILITIES

The development of water facilities as recommended herein will assist in the stabilization of operating units in the area. Such development will make possible the irrigation of family sized gardens which will contribute greatly to the food needs required by the farm family. Water spreading and flood irrigation facilities will increase the production of supplemental feed and tend to assure the production of feed in dry years.

APPENDIX I

CHART AND MAPS

Contents

Chart 1 - Geologic Section and Its Relation to Ground Water

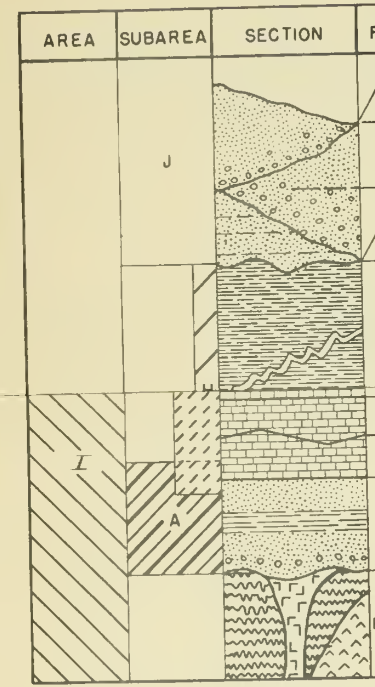
Map 1 - Existing Water Facilities

Map 2 - Geology and Ground Water

CHART I

BEAR BUTTE, ELK AND BOXELDER CREEKS WATERSHEDS — SOUTH DAKOTA

GEOLOGIC SECTION AND ITS RELATION TO GROUND WATER



AREA	SUBAREA	FORMATION	THICKNESS	CHARACTER	GROUND WATER CHARACTERISTICS
	J	ALLUVIUM	0'–30'	Gravel, Sand Clay, Laam	
		TERRACES	0'–30'	Baulders Gravels, Sand	
		BRULE CHADRON	0'–30'	Shale, Clay, Sand	
		PIERRE	1,000'–1,200	Shale	Economically unavailable except in subarea J. * SUBAREA G — flowing artesian wells should be encountered in the lower topographic locations from depths of 1,000 to 2,000 feet. Elsewhere strong artesian rises can be expected. Quantities — 25 to 100 gpm. Quality — good to poor. These wells are uneconomic unless
I		ENGLEWOOD	40'–50'	Limestone	Economically available to pumped wells only along streams from depths of 10 to 30 feet and within subarea A from depths of 50 to 200 feet. Quantities — 2 to 10 gpm. Quality — good. Best uses — farmstead and livestock supplies. SUBAREA B-principal occurrence of sinks along streams.
	A	WHITEWOOD	40'–60'	Limestane	
		DEADWOOD	200'–300'	Sandstone Shale Canglamerate	
		PRE-CAMBRIAN	1'+	Granite Schist	

Based on U.S.G.S. General Folio 219

Explanation of Terms

"Livestock water" — includes (1) stock ponds, tanks or dugouts; (2) wells; (3) spring development.
"gpm" — gallons per minute.
"Farmstead water" — includes (1) needs of livestock at or near farm buildings; (2) needs of family for domestic use; (3) irrigation of home gardens not to exceed approximately one acre.

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

U. S. DEPARTMENT OF AGRICULTURE

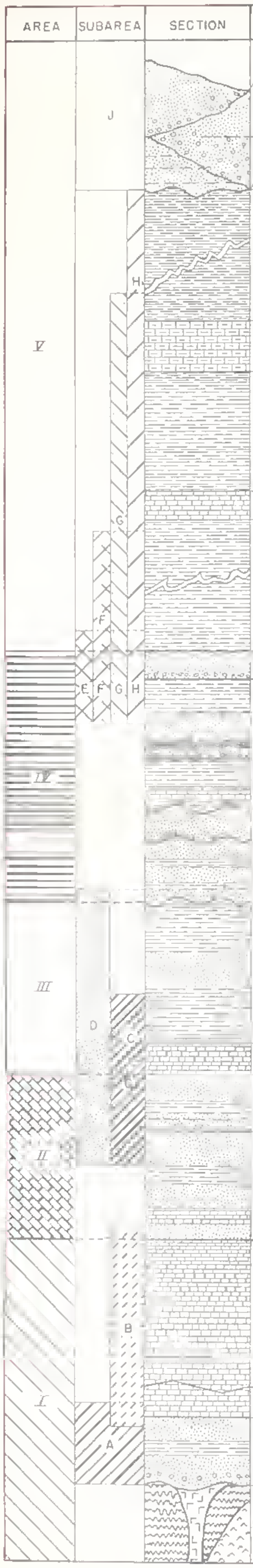
APRIL 1940
PLATE II-C-438

BUREAU OF AGRICULTURAL ECONOMICS

CHART I

BEAR BUTTE, ELK AND BOXELDER CREEKS WATERSHEDS — SOUTH DAKOTA

GEOLOGIC SECTION AND ITS RELATION TO GROUND WATER

AREA	SUBAREA	SECTION	FORMATION	THICKNESS	CHARACTER	GROUND WATER CHARACTERISTICS
V	J		ALLUVIUM	0'–30'	Gravel, Sand Clay, Loam	Economically unavailable except in subarea J * SUBAREA G – flowing artesian wells should be encountered in the lower topographic locations from depths of 1,000 to 2,000 feet Elsewhere strong artesian rises can be expected. Quantities – 25 to 100 gpm. Quality – good to poor. These wells are uneconomic unless other means of supplying livestock and farmstead water are not available SUBAREA H – same as G except depths of 2,000 to 3,000 feet will be required Quality fair to poor SUBAREA J – ground waters are available locally to pumped wells from depths of 10 to 50 feet in and along stream channels and on the broader divides. Portions of the uplands are barren of shallow ground water Valley slopes seldom afford wells although springs are common A number of wells are seasonally intermittent Quantities – ½ to 3 gpm Quality – fair to bad Best uses – livestock and farmstead supplies * The areal extent and distribution of subarea J is not shown.
	J		TERRACES	0'–30'	Boulders Gravels, Sand	
	J		BRULE CHADRON	0'–30'	Shale, Clay, Sand	
			PIERRE	1,000'–1,200	Shale	
			NIOBRARA	175'–225'	Limestone Chalk, Clay	
			CARLILE	500'–750'	Shale	
			GREENHORN	65'	Limestone	
			GRANEROS	900'–1,100'	Shale	
IV			DAKOTA	10'–40'	Sandstone	Economically available to pumped wells from depths of 10 to 300 feet Quantities 5 to 15 gpm Quality – good to fair Best uses – farmstead and livestock supplies SUBAREA E – flowing artesian wells should be encountered in the lower topographic locations from depths of 200 to 500 feet Elsewhere strong artesian rise can be expected Quantities 50 to 200 gpm Quality – good Best uses – farmstead and livestock supplies, and the irrigation of tracts larger than farmstead gardens SUBAREA F – flowing artesian wells should be encountered in the lower topographic locations from depths of 500 to 1,000 feet Elsewhere strong artesian rise can be expected Quantities 100 to 300 gpm Quality – good to fair Best uses – farmstead and livestock supplies, and the irrigation of tracts larger than farmstead gardens
			FUSON	70'	Shale, Clay	
			LAKOTA	200'–225'	Sandstone Conglomerate Coal	
			MORRISON	100'–220'	Shale Limestone	
			UNKPAPA	20'–50'	Sandstone	
			SUNDANCE	240'–275'	Sandstone Shale	
III			SPEARFISH	600'–700'	Shale Sandstone Gypsum	Economically available to pumped wells along streams from depths of 10 to 30 feet Locally available in the spearfish red beds from depths of 50 to 200 feet Quantities – 2 to 5 gpm Quality – good Best uses – farmstead and livestock supplies. SUBAREA D – flowing artesian wells should be obtained in the lower topographic locations from depths of 500 to 1,200 feet Elsewhere strong artesian rises can be expected Quantities – 100 to 500 gpm Quality – good. Best uses – farmstead and livestock supplies, and the irrigation of tracts larger than farmstead gardens
			MINNEKAHTA	40'	Limestone	SUBAREA C – See II C
II			OPECHE	90'	Shale Sandstone	Economically available to pumped wells from depths of 10 to 200 feet Quantities – 5 to 15 gpm Quality – good Best uses – farmstead and livestock supplies SUBAREA C – flowing artesian wells should be obtained in the lower topographic locations from depths of 200 to 500 feet Elsewhere strong artesian rises can be expected Quantities 50 to 300 gpm Quality – good Best uses – farmstead and livestock supplies, and the irrigation of tracts larger than farmstead gardens
			MINNELUSA	450'	Mostly sandstone	
I			PAHASAPA	500'–600'	Limestone	Economically available to pumped wells only along streams from depths of 10 to 30 feet and within subarea A from depths of 50 to 200 feet Quantities – 2 to 10 gpm Quality – good Best uses – farmstead and livestock supplies SUBAREA B – principal occurrence of sinks along streams
			ENGLEWOOD	40'–50'	Limestone	
			WHITEWOOD	40'–60'	Limestone	
			DEADWOOD	200'–300'	Sandstone Shale Conglomerate	
			PRE-CAMBRIAN	1'+	Granite Schist	

Based on U.S.G.S. General Folio 219

Explanation of Terms

"Livestock water" – includes (1) stock ponds, tanks or dugouts, (2) wells, (3) spring development

"gpm" — gallons per minute

"Farmstead water" – includes (1) needs of livestock at or near farm buildings, (2) needs of family for domestic use, (3) irrigation of home gardens not to exceed approximately one acre

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

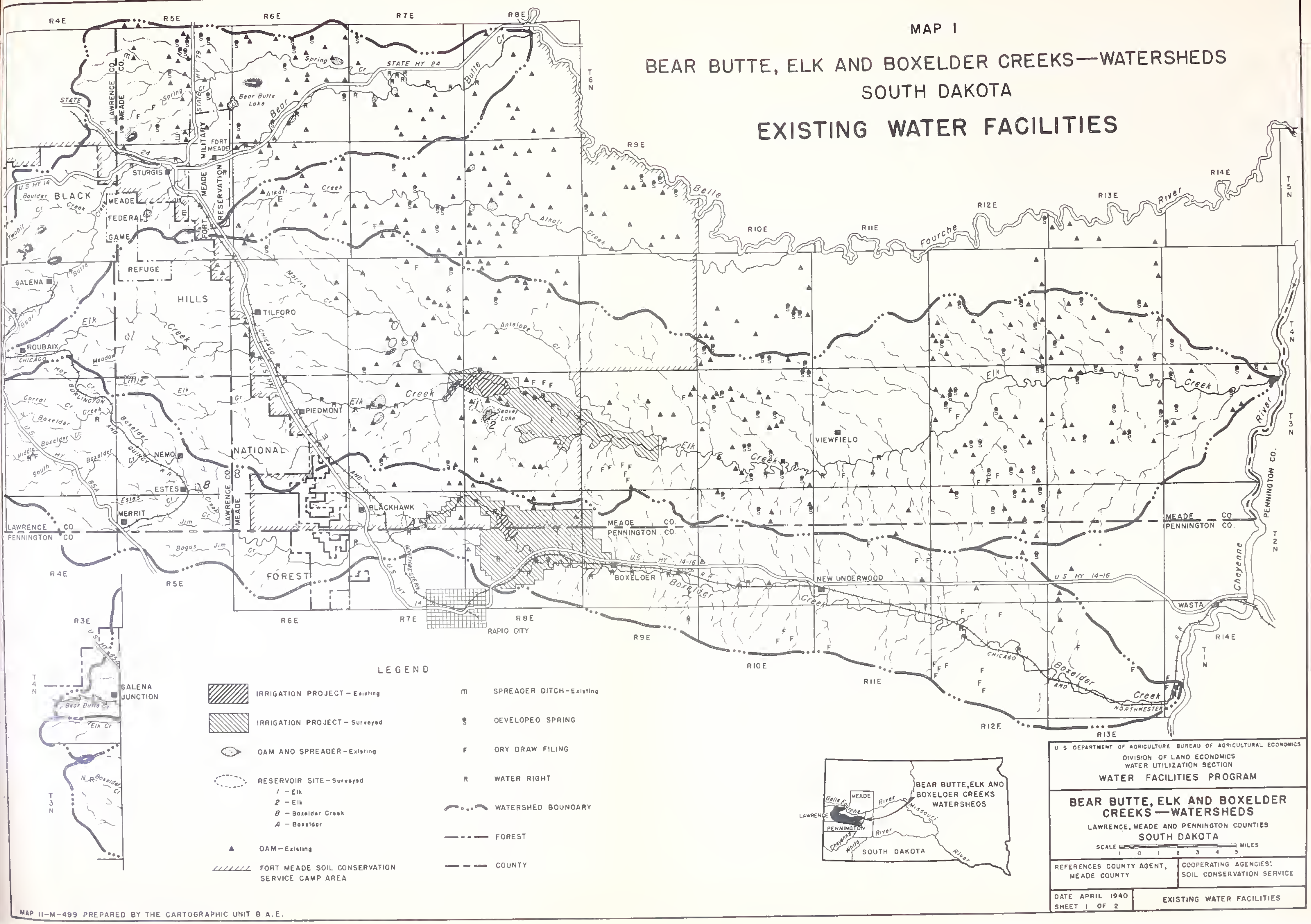
U. S. DEPARTMENT OF AGRICULTURE

APRIL 1940
PLATE II-C-438

BUREAU OF AGRICULTURAL ECONOMICS

MAP I

BEAR BUTTE, ELK AND BOXELDER CREEKS—WATERSHEDS
SOUTH DAKOTA
EXISTING WATER FACILITIES



U S DEPARTMENT OF AGRICULTURE BUREAU OF AGRICULTURAL ECONOMICS
DIVISION OF LAND ECONOMICS
WATER UTILIZATION SECTION
WATER FACILITIES PROGRAM

BEAR BUTTE, ELK AND BOXELDER CREEKS—WATERSHEDS
LAWRENCE, MEADE AND PENNINGTON COUNTIES
SOUTH DAKOTA

REFERENCES COUNTY AGENT, MEADE COUNTY

COOPERATING AGENCIES: SOIL CONSERVATION SERVICE

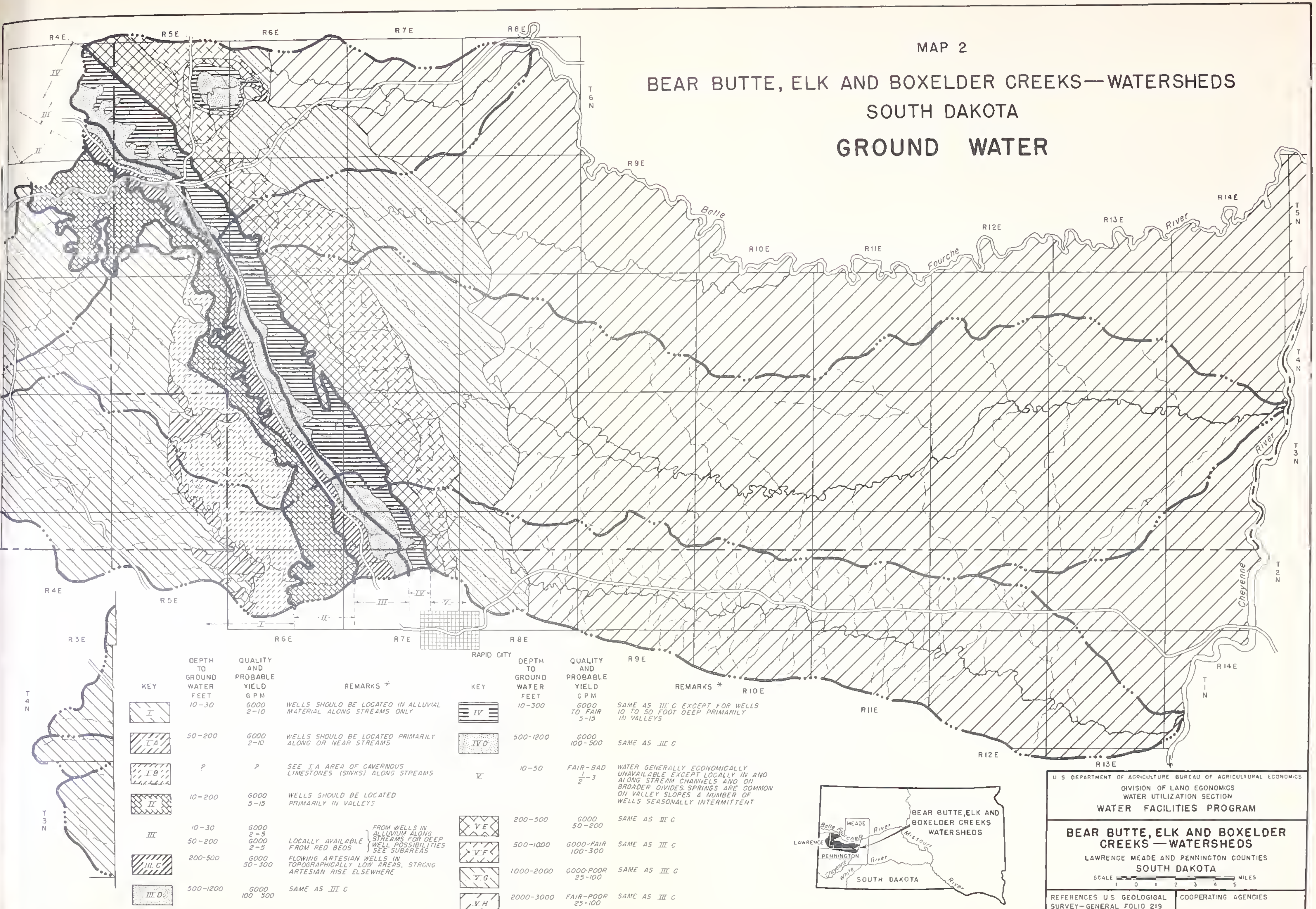
DATE APRIL 1940
SHEET 1 OF 2

EXISTING WATER FACILITIES

MAP II-M-499 PREPARED BY THE CARTOGRAPHIC UNIT B.A.E.

MAP 2

BEAR BUTTE, ELK AND BOXELDER CREEKS—WATERSHEDS
SOUTH DAKOTA
GROUND WATER



KEY	DEPTH TO GROUND WATER FEET	QUALITY AND PROBABLE YIELD GPM	REMARKS *
I	10-30	GOOD 2-10	WELLS SHOULD BE LOCATED IN ALLUVIAL MATERIAL ALONG STREAMS ONLY
I A	50-200	GOOD 2-10	WELLS SHOULD BE LOCATED PRIMARILY ALONG OR NEAR STREAMS
I B	?	?	SEE I A AREA OF CAVERNOUS LIMESTONES (SINKS) ALONG STREAMS
II	10-200	GOOD 5-15	WELLS SHOULD BE LOCATED PRIMARILY IN VALLEYS
III	10-30 50-200	GOOD 2-5 GOOD 2-5	FROM WELLS IN ALLUVIUM ALONG STREAMS LOCALLY AVAILABLE FROM RED BEDS FOR DEEP WELL POSSIBILITIES SEE SUBAREAS
III C	200-500	GOOD 50-300	FLOWING ARTESIAN WELLS IN TOPOGRAPHICALLY LOW AREAS, STRONG ARTESIAN RISE ELSEWHERE
III D	500-1200	GOOD 100 500	SAME AS III C
IV	10-300	GOOD TO FAIR 5-15	SAME AS III C EXCEPT FOR WELLS 10 TO 50 FOOT DEEP PRIMARILY IN VALLEYS
IV D	500-1200	GOOD 100-500	SAME AS III C
V	10-50	FAIR-BAD $\frac{1}{2}$-3	WATER GENERALLY ECONOMICALLY UNAVAILABLE EXCEPT LOCALLY IN AND ALONG STREAM CHANNELS AND ON BROADER DIVIDES. SPRINGS ARE COMMON ON VALLEY SLOPES A NUMBER OF WELLS SEASONALLY INTERMITTENT
V E	200-500	GOOD 50-200	SAME AS III C
V F	500-1000	GOOD-FAIR 100-300	SAME AS III C
V G	1000-2000	GOOD-POOR 25-100	SAME AS III C
V H	2000-3000	FAIR-POOR 25-100	SAME AS III C

* UNLESS OTHERWISE STATED WELLS MAY BE LOCATED IN ANY AREA DEPTHS AND SUCCESS OF MANY WELLS WILL VARY WITH TOPOGRAPHIC AND GEOLOGIC CONDITIONS

U S DEPARTMENT OF AGRICULTURE BUREAU OF AGRICULTURAL ECONOMICS
DIVISION OF LAND ECONOMICS
WATER UTILIZATION SECTION
WATER FACILITIES PROGRAM

BEAR BUTTE, ELK AND BOXELDER CREEKS —WATERSHEDS
LAWRENCE MEADE AND PENNINGTON COUNTIES
SOUTH DAKOTA
SCALE 1 0 1 2 3 4 5 MILES

REFERENCES U S GEOLOGICAL SURVEY—GENERAL FOLIO 219

COOPERATING AGENCIES

DATE APRIL 1940
SHEET 2 OF 2

GROUND WATER

MAP 11-M-500 PREPARED BY THE CARTOGRAPHIC UNIT B A E